A Comprehensive Review of Forever Chemicals (PFAS)

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Eye makeup, shampoo, dental floss, cleaning products, rain jackets, and nonstick cookware all share a common characteristic: the presence of PFAS, or "forever chemicals." PFAS, which stands for perfluoroalkyl and polyfluoroalkyl substances, are man-made chemicals that make these items water, stain, heat, and grease-resistant. First discovered in the late 1930s, PFAS have been used so prevalently in society that almost every person in the world has noticeable levels of PFAS chemicals in their blood. This is a problem because these "forever chemicals" are nearly indestructible as a result of their chemistry and are toxic at low levels, posing risks to human health.

The structure of PFAS is important to understanding their unique chemical properties and recalcitrant nature. Simply put, PFAS consist of carbon atoms linked to each other and bonded to fluorine atoms. The bond between the carbon and the fluorine is one of the strongest bonds in organic chemistry and nearly impossible to break down. A subgroup of PFAS have a hydrophilic—attracted to water—head and a hydrophobic—repels water—carbon-chain tail, acting as surfactants and reducing the surface tension of water, while they are also water 'resistant.' However, the harmful part of these bonds being so strong is that they cause PFAS to be extremely persistent and remain in nature for thousands of years. In fact, aqueous-phase PFAS can be transported over far distances without breaking down. With the help of humans, birds, and fish, these chemicals can go to remote places; in fact, some polar bears have been found with PFAS in their bloodstreams.

PFAS has vast uses in the modern world–industries use them for candy wrappers, nail polish, fast food packaging, and even shampoo. Even though PFAS are used in many aspects of

modern life, most people are not aware of the presence of these chemicals in things they consume and in the items they use every day. For example, many people do not know there can be PFAS in one of the things they require the most, drinking water. In industrial facilities where firefighting foam is used, drinking water can be contaminated by PFAS-contaminated water supplies. More recently, more research has been uncovered about the use of PFAS in agriculture. For decades, the U.S. Environmental Protection Agency (EPA) has encouraged farmers all across America to use sewage waste, with alarmingly high numbers of PFAS, to fertilize their land. The contents of the waste effectively provide rich nutrients to the land, but now it is becoming an increasingly urgent problem for the farmers' health.

Even though PFAS have remained a very important part of modern daily life, they are very detrimental to both humans' health and the environment. According to numerous animal studies investigating the effect of PFAS on living organisms, PFAS can cause damage to the liver and the immune system. These chemicals also cause low birth weight, birth defects, delayed development, and newborn deaths in lab animals. Although humans and animals have different bodily systems, PFAS has also been proven to have substantial effects on humans as well. According to the EPA, these PFAS can cause increased risk of some cancers, including prostate, kidney, and testicular cancers; reduced ability of the body's immune system to fight infections, including reduced vaccine response; interference with the body's natural hormones; and increased cholesterol levels and/or risk of obesity. All of these health risks can be acquired just from, say, eating a McDonald's hamburger from their grease-free packaging. However, despite pressing issues that PFAS bring to humans, the EPA doesn't regulate or test for most PFAS chemicals. This causes many people to not know whether or not they are ingesting these harmful chemicals even when they are doing simple actions, like flossing or using cleaning products.

Fortunately, however, the EPA has just recently announced the final National Primary Drinking Water Regulation for 6 PFAS. The EPA hopes that this new regulation will allow people to be more safe when drinking water, preventing tens of thousands of PFAS-related deaths and illnesses.

Despite general lack of awareness, some states and corporations in the U.S. have taken action in spreading awareness about the dangers of PFAS. In fact, Colorado passed a law that prohibited PFAS in carpets, rugs, fabric treatments, food packaging, juvenile products, and oil and gas products by 2024. In October 2021, the EPA launched its PFAS Strategic Roadmap to research, restrict, and reduce PFAS.

Since the 1950s, PFAS have been an ongoing problem, causing health and environmental harm. As people become increasingly aware of this damage, new solutions and alternatives to PFAS are being brought up and implemented, paving the way to a more healthy and environmentally-friendly world.

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